Effect of thatch on water-soluble phosphorus of pasture soil fertilized with broiler litter

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Abstract: The presence of a thatch layer in established pastures could reduce the contact between broiler litter and soil, thus increasing the potential for surface runoff contamination with litter P. We conducted a laboratory study to evaluate the effect of a thatch layer on the dynamics of water-soluble P in undisturbed cores taken from a pasture. Cores with and without a thatch layer received a surface application of broiler litter (5 t hm^{-2}) and were incubated at 25 °C for 56 d. The result showed that on the soil surface the contents of water soluble-P (39 kg hm^{-2}) of the cores with the thatch layer was higher than that (20 kg hm^{-2}) of the cores without the thatch layer. Therefore on well-established pastures fertilized with broiler litter, the presence of a thatch layer might lead to high concentrations of water-soluble P on the soil surface.

Keywords: Pastures; Water-soluble phosphorus; Broiler litter
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Introduction

Broiler litter is a by-product of broiler production and consists of poultry excreta, feathers, wasted feed, and bedding material (Moore *et al.* 1995). Bosch and Napit (1992) concluded that the use of broiler litter as a nutrient source is an economical alternative to commercial fertilizers. Broiler litter contains high concentrations of water-soluble phosphorus, and generally much of the litter is broadcast to fields close to the production facility. Well-established pastures usually have a thatch layer that may reduce the contact between litter and soil, thereby reducing phosphorus absorption by the soil. Consequently, the presence of a thatch layer may lead to high concentrations of water soluble phosphorus on the soil surface, which in turn may increase the risk of surface water contamination with Phosphorus.

Normally, the pastures have a significant amount of thatch. The broiler litter may persist in the soil surface for a long time when broiler litter was surface applied to pasture, and extending to the occurrence of rainfall and runoff. However, it is not clear that the dynamic of water-soluble P on the soil surface, and in the top 1 cm soil of pastures fertilized with broiler litter, and how that is affected by the presence of the thatch layer.

A few studies have investigated P runoff losses from pasture applied broiler litter (Edwards and Daniel 1992, 1993, 1994; Heathman *et al.* 1995; Nichols *et al.* 1994; Shreve *et al.* 1995; Vervoort *et al.* 1998; Kuykendall *et al.* 1999). The parameters included soil characteristics, slop, and tillage, timing, quantity, and method of application of fertilizers, and intensity, quantity, and timing of rainfall. The results showed that the majority of P in runoff from poultry litter was soluble, and suggested that most effective practices to lessen the impact of poultry litter on water quality should focus on reducing soluble P losses (Edwards *et al.* 1996).

This study was conducted to evaluate the effect of a thatch layer on the dynamics of water soluble P on the soil surface and in the upper soil of 1 cm in depth in undisturbed cores taken from a pasture.

Materials and methods

Four treatments were set to study the effect of thatch on water-soluble P in pastures fertilized with broiler litter. The treatments were: a) Control, soil without thatch. b) Soil with thatch. c) Soil without thatch plus broiler litter. d) Soil with thatch plus broiler litter. The rate of broiler litter applied was equal to 5 t· hm^{-2}.

The acrylic cylinder (4.4 cm diameter, 10 cm high) was used to sample undisturbed soil core with or without thatch. The soil cores were sampled from a fescue-bermudagrass pasture. Cylinders were placed into incubator at 25 °C for 8 weeks. Three cylinders for each treatment were sampled on specified days: 1, 3, 7, 14, 28, and 56. The upper soil of 1 cm in depth and top layer of thatch, litter, or both were sampled and extracted by deionized water at the water-to-litter ratio 200:1. Blinds were shaken at 120 opm for 4 hours then were centrifuged at 5 000 revolutions for 5 min to separate solids. Supernatant solution was filtered through a 0.45 μm filter. Phosphorus was determined by the molybdate-blue procedure.

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Results and discussion

Effect of thatch on dynamic of water-soluble P in upper soil of 1 cm in depth

The contents of water soluble P in upper 1 cm soil showed a rapid increase during the first week after broiler litter was fertilized, followed by a slower increase for 3 weeks and reached the stable top under the treatment without thatch. Whereas, the contents of water soluble P under the treatments without broiler litter, no matter with or without thatch, showed a stable fluctuation from 1.2-2.4 kg hm^{-2} during the whole 8-week incubation period (Fig. 1). The dynamic of water-soluble P contents fertilized with broiler litter were of significant difference between the treatments without thatch and with thatch. The contents of water-soluble P of no thatch treatment increased continually since fertilized with broiler litter, and then reached the balance at the 4th week, which seemed means that P-absorption had been saturated in soil. The contents of water-soluble P were stable on a lower level from beginning to the 4th week under the treatments with thatch and fertilized with broiler litter, and then had a little higher increase during the next 4 weeks, which indicated that the thatch layer could retain the litter for at last 2 months. The contents of water-soluble P were of no apparent difference between the treatment without thatch and broiler litter and treatment with thatch but no broiler litter. Compared with no thatch treatment, the presence of a thatch layer could significantly decrease the contents of water-soluble P in upper soil of 1 cm in depth for which could clearly reduce the touching chance between broiler litter and soil (Table 1).

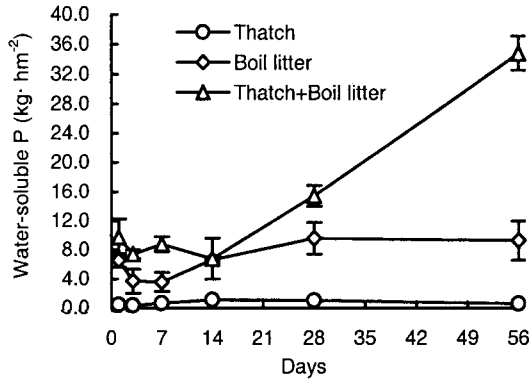

Fig. 1 The dynamic of water-soluble P in upper soil of 1cm in depth under different treatments

Table 1. Analysis of variance for effect of different treatment on water-soluble P in upper 1cm litter

Treatments	LSMEAN kg· hm^{-2}	P>F			
		a	b	c	D
a) Soil only	1.59	-	0.4645	0.0001	0.0004
b) Soil with thatch	1.90	0.4645	-	0.0001	0.0035
c) Soil plus broiler litter	7.61	0.0001	0.0001	-	0.0001
d) Soil with thatch plus broiler litter	3.17	0.0004	0.0035	0.0001	-

Effect of thatch on dynamic of water-soluble P on soil surface

The amount of water-soluble P in thatches only remained stable low level throughout 8-week incubation. The contents of water-soluble P in the residues of broiler litter decreased rapidly during the first 3 days owing to the fast soil P-absorption. Along with soil P-absorption getting slow and the soluble P releasing from decomposition of broiler litter, the contents of water-soluble P in the residues increased gradually and slowly during the following 3 weeks, and then reached a stable level during the next 4 weeks owing to the balance between the slow P release from decomposition of broiler litter and soil P-absorption (Fig. 2).

Old pastures had a large amount of thatch on the soil surface and their thickness was about 2 to 3 cm. The presence of a thatch layer in pastures had a significant effect on the amount of soluble P remaining on top soil (Table 2). The reason was that the thatch layer retarded the fertilized broiler litter in touch with soil, and retained the water-soluble P in broiler litter for a long time. Furthermore, it increased the potential contamination of soluble P to surface runoff water. The dynamic of water-soluble P in the residues of broiler litter that fertilized to the soil with thatch was of significant difference compared with that fertilized to the soil with no thatch.

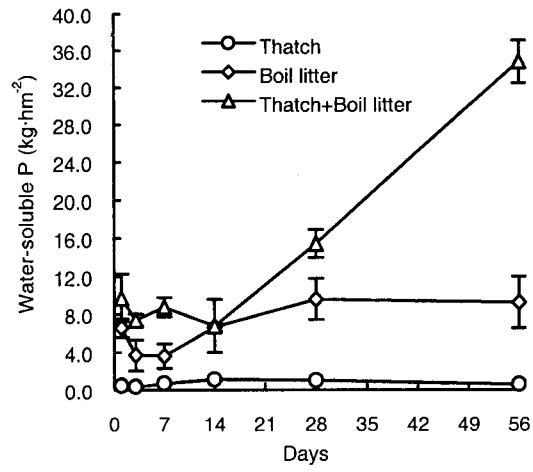

Fig. 2 The effect of thatch on dynamic of water-soluble P in Thatch, BL or both on the soil surface

Table 2. Analysis of variance for effect of different treatments on water-soluble P in Thatch, Broiler litter or both

Treatments	LSMEAN	P>F		
	kg· hm^{-2}	b	c	d
b) Soil with thatch	0.75	-	0.0001	0.0001
c) Soil plus broiler litter	6.36	0.0001	-	0.0001
d) Soil with thatch plus broiler litter	13.01	0.0001	0.0001	-

Conclusion

The presence of thatch layer could affect the dynamic of water-soluble P significantly both in upper soil of 1 cm in depth and in the soil surface layer during the whole 8-week incubation period. Water-soluble P in upper soil of 1 cm in depth showed a rapid increase in the treatment with no thatch but fertilized with broiler litter during the first week, but water-soluble P in the residues of litter decreased rapidly owing to the intense P soil absorption. Thereafter, water-soluble P both in upper soil of 1 cm in depth and in the residues increased slowly during the following days. Compared with the treatment with no thatch but fertilized with broiler litter, water-soluble P in the upper soil of 1 cm in depth showed a stable lower level in the treatment with thatch and fertilized with broiler litter during the whole incubation period. Water-soluble P in thatch and litter showed a distinct increase from the second week to the end of incubation, which induced a potential contamination of soluble P to surface runoff water.

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